Activity Overview

In this activity students will learn the scales used to describe the size of earthquakes. They will rate the different intensities felt in different cities for a single earthquake and plot these intensities on a map to approximate the area where an earthquake originated. A web-based activity will show how the amplitude of earthquake waves is used to measure the magnitude of an earthquake. The connection between variation in local geology and the intensity of the earthquake will be introduced.

At the conclusion of **Activity 3**, students should be able to describe the two scales used to measure the size of earthquakes. Given appropriate data, they should be able to interpret effects or read seismograms to assign an intensity or magnitude. Each student group should be able to explain how earthquakes are measured as part of their **Chapter Challenge** project. Content reading examines the difference between measuring earthquakes by intensity (using the Modified Mercalli Scale) or by magnitude (using the Richter scale). The reading also explains how local geologic conditions can impact the amount of damage caused by an earthquake.

Preparation and Materials Needed

No additional preparation is needed for this activity. Students will need copies of the map of eastern United States. See **Blackline Master Earthquakes 3.1** in this Teacher's Edition. The second part of **Investigate** requires access to the worldwide web.

Go to the *EarthComm* web site for a link to the Virtual Earthquake web site and simulate a new earthquake. Follow the directions to calculate the magnitude of the earthquake.

Think about It

Student Conceptions

The questions at the start of every *EarthComm* activity are designed to engage student thinking about the problem or focus of the upcoming investigation. The primary focus of the current activity is to explore the concept of earthquake measurement. Have students respond to the questions individuals, share with a partner, then discuss in small groups. The **Think about It** section is intended as a brief warm-up activity. The answers below are for you, the teacher, to consider, but do not feel compelled to reinforce these responses at the start of the activity. Allow students to share their ideas freely and comfortably in this stage of the activity.

Students are likely to take an egocentric approach to answering this question. They will likely focus on the amount of damage caused by an earthquake and the reactions of the public to the quake as a means of measuring its size. Students who think back to the previous activities will probably measure the amount of ground shaking and the size of the waves associated with the earthquake. In answering the second question, students will equate the more scientific data, such as wave amplitude, with the seismologist, and damages incurred to the city planner and homeowners.

Answer for the Teacher Only

In order to measure the size of an earthquake, students would probably want to look at the damage done, what people experience, how much the ground shakes, and the size of the waves.

A seismologist would want measurements independent of human observers that could be used to describe the motion of waves at the surface or to describe the interior of the Earth. A city planner would want to know how much damage, and of what kinds, an earthquake might cause and how it might vary from area to area within the city. Homeowners would want to know how much damage, and of what kinds, an earthquake might cause to their homes.

Assessment Tool

Think about It Evaluation Sheet

The **Think about It Evaluation Sheet** can be used to assess the extent to which students have met the basic expectations for the warm-up activity.

Investigate

Part A: Measurement of Earthquake Effects

Teaching Tips

A copy of the map of the eastern United States that you can copy for students is provided as **Blackline Master Earthquakes 3.1** in this Teacher's Edition.

Make copies of the map on overhead transparencies. Students can plot their data directly onto the overhead and project their results for discussion in **Question 4**.

Circulate from group to group asking questions that help the students better understand the concepts of intensity and magnitude. They should note the need for human observers for intensity measurements.

2. The results of this contouring exercise will vary considerably, depending on how intensity values are assigned to the various cities. A map of intensities is likely to have inconsistencies because of local effects on intensities. Contouring somewhat inconsistent data like this is usually frustrating, because the location of the contour lines is inherently somewhat uncertain. You can reduce the students' frustration level by explaining that this procedure is inherently uncertain and that there is no "right" pattern of contour lines.

Teaching Tip

Type out the newspaper data and print copies for the students. Then have the students cut the paper into strips and place them in order based on intensity.

Assessment Tool

***EarthComm* Notebook Entry-Checklist**
Refer students to the ***EarthComm* Notebook Entry-Checklist** to remind them of the criteria against which they will be assessed. The checklist also provides a quick guide for student self-assessment and also provides you with an opportunity to quickly score student work.

3. The contour map should show an overall trend of decreasing intensity away from the mid-Atlantic coast area. Most students will conclude that the epicenter was not far from Washington, D.C., which reported the strongest effects.

4. **a)** Results are likely to vary considerably.

b) The estimates are likely to be fairly close.

c) The problems reflect the difficulty of accurate contouring, as noted above.

d) The conventional procedure for locating the earthquake epicenter was discussed at some length in an earlier activity. It would take far more extensive data from seismological stations to locate the epicenter closely.

e) Answers will vary.

f) It is inherently qualitative.

g) The intensity reflects the effects of the passing seismic waves, which is related closely but only indirectly to the properties of the seismic waves themselves.

Part B: Measurement of Earthquake Wave Amplitude

Teaching Tip

Go to the *EarthComm* web site www.agiweb.org/earthcomm to link to the Virtual Earthquake web site. Students can follow the directions to take them through the exercise. They can choose to examine data from three separate locations. You may want to tell them which region to select to help standardize the answers.

b) The size of an earthquake increases as the amplitude of the seismic waves increases.

c) The amplitude decreases with distance away from the epicenter.

Reflecting on the Activity and the Challenge

This is an opportunity to note the observations the students should have made. The students are now aware of two scales to measure the size of an earthquake. Personally, they could observe and report on the intensity of an earthquake. To determine the magnitude, they would need a seismogram (to measure amplitude) and the distance to the epicenter. They learned these latter skills during the web-based exercise.

Digging Deeper

Assign the reading for homework. The questions in **Check Your Understanding** on page 146 can be provided as a homework assignment.

Assessment Opportunity

Use a quiz to assess student understanding of the concepts presented in the activity. Some sample questions are listed below.

- Explain the difference between measurements of earthquake intensity and earthquake magnitude.

(Intensity is a measure of the effects of an earthquake on the Earth's surface, while magnitude is a measure of the amplitude of the waves generated by an earthquake.)

- How can the local geology of an area influence the extent of damages incurred by an earthquake?

(In general, seismic waves will increase in amplitude as they pass from solid materials, such as bedrock, to softer materials, such as sand or mud. Liquefaction can occur in water-saturated materials. Hence, earthquakes which shake softer ground can cause more damage than quakes which shake solid ground.)

- The amplitude of seismic waves created by an earthquake with a Richter magnitude of 7.0 is how many times greater than a magnitude 6.0 earthquake?

(Magnitude scales are logarithmic, based on powers of 10. So, seismic wave amplitudes increase by a factor of 10 for each unit on the scale.)

Check Your Understanding

1. Earthquake intensity is a direct reflection of the extent of damage at a given locality.

2. Answers will vary somewhat but should be fairly consistent with the descriptions given in the **Digging Deeper** reading section.

3. No, because the nature of the Earth materials influences the intensity of ground motions produced by seismic waves of given energy.

4. For an earthquake of given energy, intensities are generally least in localities underlain by solid bedrock and greatest in areas underlain by loose, deformable, and/or water-rich earth materials.

5. Earthquake magnitude is a measure of the amplitude of seismic waves.

Assessment Tool

Check Your Understanding Notebook Entry-Evaluation Sheet
This evaluation sheet is used to help you evaluate the extent to which students understand the key concepts explored in the activity and explained in the **Digging Deeper** reading section.

Understanding and Applying What You Have Learned

Stress that answers to the questions and related explanations are to be based on evidence.

1. Make sure that students note that each line in the table shows a range of both magnitudes and intensities. There is a general correlation between magnitude and intensity, but because of the variability of local substrate conditions, the correlation is not perfect.

2. An earthquake with intensity VII/magnitude 5.0–5.9 would be exciting because furniture would move about and maybe some plaster might fall. It might cause some damage but probably no deaths. Larger earthquakes tend to cause considerable damage, and the likelihood of death is higher.

3. **a**) More than 350,000.

b) No.

c) Answers will vary. Something like 10 to 20, worldwide, are reported in the popular news media each year, but probably most students will have heard of only a few of these.

d) The magnitude is probably 7 or greater, but there are notable exceptions. Smaller quakes can cause considerable damage and a large number of deaths in countries where building codes are not used. For example, in 1960 a magnitude 5.8 earthquake in Morocco killed 12,000 people. Areas where earthquakes are infrequent commonly report smaller earthquakes.

e) Probably yes. It may cause students to think all earthquakes are big and that they are fairly rare events. The table on page 147 should help correct this misconception.

Preparing for the Chapter Challenge

Students should be discouraged from copying earthquake measurement scales word for word into text boxes. Rather, they should summarize the methods and the advantages and disadvantages of each method. They should illustrate the methods with some examples.

Inquiring Further

1. Reporting earthquakes

The *EarthComm* web site www.agiweb.org/earthcomm links students to report forms. They can also view current data. As an extension, you may ask them to design their own earthquake report form, specific to their community.

2. Determine the intensity of an earthquake from a description

Students should be able to find someone who has experienced an earthquake, be it a fellow student, a friend, or a relative. This will likely be a very interesting conversation for the students, particularly if they have not experienced an earthquake for themselves. They may wish to share their findings with the class.

3. Investigate earthquake measurement

Have students prepare a list of questions of things they wish to know about earthquake study. Make a composite list of all of the questions and have each student or student group research a different question. They can then present their findings to the class. The *EarthComm* web site contains a list of relevant web links which will help students to research how scientists measure earthquakes.